Virginia City Hybrid Energy Center
Response to Data Request
Bruce Buckheit, Member, Virginia Air Pollution Control Board

Question (Page No. 9):

There needs to be some assessment of whether the possible adoption of minimum biomass requirements will cause adverse environmental effects. There are a number of large industrial boilers operating in this country that operate either entirely with wood as a fuel or utilize a mix of wood or coal and so there may be information available that discusses the issue. Specific attention should be paid to any local impacts that might be unique to the area, and I assume the information obtained could be summarized in a few pages. However, given available biomass resources in the Wise County area (see below) it appears that this issue will not significantly impact estimates of annual emissions.

Response:

Dominion proposes to use biomass as one of the fuels for the Virginia City Hybrid Energy Center (VCHEC). The following discussion is taken from the report, Regional Analysis of Opportunities for Woody Biomass as a Bioenergy Feedstock, prepared by Virginia Tech (Attachment 1). For illustrative purposes, it is based on an assumption that 55 megawatts (MW), approximately 10 percent of the net energy production, would be produced from woody feedstock. While this report is based on 10 percent of the net energy production coming from biomass, the VCHEC is permitted to burn up to 20 percent biomass. Based on woody biomass fuel characteristics, this would equate to just over 400,000 *air-dry* tons per year. The expected average moisture content of the delivered biomass is however expected to be over 50% ('green') which significantly reduces the available BTU/#, and subsequently the power station will require approximately 890,000 tons of green woody biomass per year.

Current forest removal levels in Virginia are lower than the rate of forest growth, meaning that there is an annual increase in the amount of wood in the state's forests every year. The major source of reduction of forests is conversion to other uses, mainly industrial or residential. Within the procurement radius of the proposed power plant sites, there was a net growth of 419 million cubic feet on private timberlands. This figure does not include the growth from government lands or land without a suitable number of trees to be considered economically merchantable. This represents an annual surplus of 9.4 million tons of wood (2.1 million tons in Virginia) that could be removed from private forestlands without reducing the total growing stock of forests within 100 miles of the power plant locations. Thus, even if the facility were to procure its supply entirely from standing timber, the maximum annual consumption of the facility would only represent 4% of the current annual net growth in the area, and the forests would continue to add over 400 million cubic feet of volume each year. Shrinking the area in question to the 50 miles immediately around the sites shows a surplus of 130 million cubic feet or 2.9

million tons per year. Thus, if the power plant were to operate at full capacity using just standing timber from the 50 miles immediately surrounding it, the volume of standing wood in this area would still increase by over 110 million cubic feet each year.

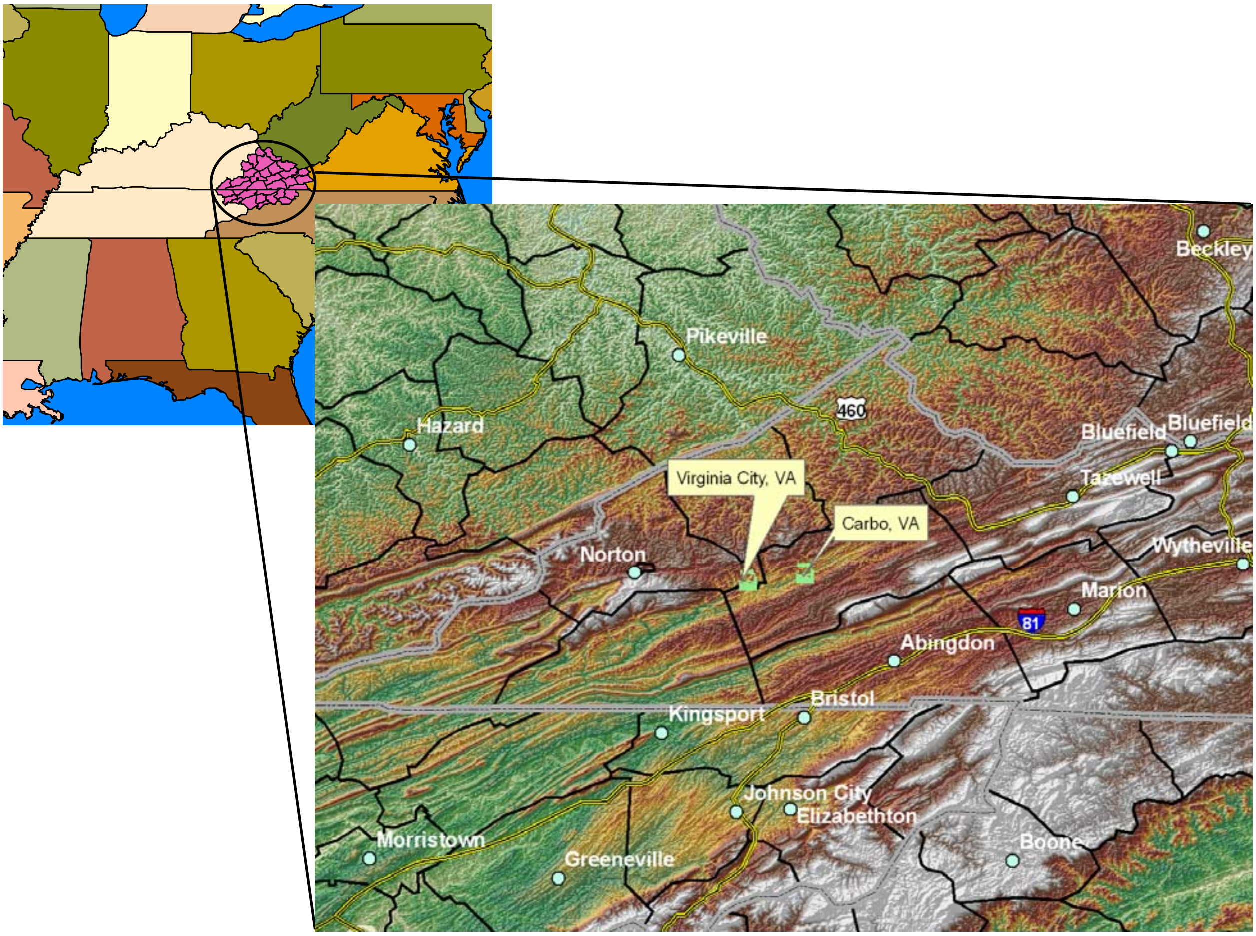
Forest management in Southwest Virginia faces numerous obstacles including operational difficulties due to steep terrain, historical poor management practices, and lack of markets for low-grade materials. One of the most unfortunate manifestations of these difficulties has been a continuing trend towards “high-grading” in many areas. High-grading refers to removing larger high-value trees while leaving poor-quality and smaller trees. The result is that these low quality trees are left to regenerate the site, producing more poor-quality trees. Without a market for low-quality material, there is no incentive to stop this trend. A facility able to accept chips from low-grade material offers the opportunity to provide an incentive to reduce high-grading in favor of stand improvement harvests, wherein low-quality material can be removed and the higher-quality trees can be left to grow with reduced competition.

ATTACHME T 1

APPENDIX E: Case Study
(Regional Analysis of Opportunities for Woody Biomass as a Bioenergy Feedstock)

In the winter of 2006 the investigators were asked to assist the Virginia Coalfield Economic Development Authority (VCEDA) to estimate potential biomass utilization in S.W. Virginia for a co-fired electricity generation plant. This report demonstrates how the findings of our research can be applied to a region. Permission was obtained by VCEDA to include the findings with our study.

Regional Analysis of Opportunities for Woody Biomass as a Bioenergy Feedstock



Prepared by

Shawn Baker, Dr. Robert Smith and Dr. Rien Visser
Virginia Tech

This report presents a regional analysis of opportunities for woody biomass as a bioenergy feedstock for the proposed co-fired power plant at either Carbo (Russell Co.) or Virginia City (Wise Co.), both in southwestern Virginia. The initial design consideration calls for supporting 55 megawatts (MW) of energy production from woody feedstocks. Based on woody biomass fuel characteristics, this would equate to just over 400,000 *air-dry* tons per year. The expected average moisture content of the delivered biomass is however expected to be over 50% (‘green’) which significantly reduces the available BTU/#, and subsequently the power station will require approximately 890,000 tons of green woody biomass per year.

Three categories of woody biomass have been identified and quantified;

(1) ‘residues’, which are the byproducts from processes and for which there is little market competition,
(2) ‘clean chips’, which are either a primary product or co-product from a processing facility for which the main competitor is the pulp and paper industry, and
(3) ‘dirty chips’ which would come directly from additional harvesting operations working with the net increase in standing timber volume from forested lands in the area surrounding the proposed mill sites.

Currently, 504,000 tons of green woody residues are produced each year from existing wood-utilizing facilities in the counties surrounding the two proposed power plant locations. Utilization of logging residue currently left by Appalachian harvesting operations could represent a significant source of low-cost residue feedstock; if 50% is recovered this would amount to an additional 230,000 tons/yr.

In addition, 527,000 green tons/yr of chips are currently produced either as the primary product, or as a co-product, for which the main market competition is the pulp and paper industry. Most comes from the wood chipping facility located 25 miles away from the proposed sites. This mill currently has 50,000 tons per year of additional chipping capacity, as well as the ability to increase another 250,000 tons annually by adding a second labor shift (if safeguards are in place to ensure a market for that material). To realize this potential, this volume would have to be harvested and transported as ‘pulpwood’ to the chipmill, whereby current timber harvesting capacity could easily supply this demand.

Note: These estimates are based on our survey and site visits specifically for this region. Other state wide studies by the Forest Service as well as a more recent Virginia Department of Forestry / Virginia Tech study would suggest these numbers are slightly conservative (i.e. low).

The standing forest resource in the 100 mile radius area surrounding the proposed power facility locations is growing 9.4 million tons more than is being harvested each year. If additional logging and processing (in-woods chipping) capacity were introduced to the area, this substantial volume of woody biomass could be made available to the power plant without jeopardizing the long-term sustainability of the forest.

Table 1: Biomass availability summary table (in 1000s tons per year) for the area surrounding the proposed power plants (90 minute drive time from proposed mill locations).

Residues

	Sawdust	Chips	Bark	Total		VA only
Primary wood processors	136	*n/a*	130	266		(111)
Secondary wood processors	155	23	*n/a*	178		(64)
Chip mill	17.5	*n/a*	42.5	60		(60)
Logging residues *(potential if 50% reclaimed)*	*n/a*	230	*n/a*	230		(109)
Totals	***308.5***	***230***	***172.5***	***734***		***(344)***

Chip Production

	Sawdust	Chips	Bark	Total		VA only
Primary wood processors	*n/a*	277	*n/a*	277		(116)
Chip Mill *(current production)*	*n/a*	250	*n/a*	250		(250)
Chip Mill *(potential production)*	*n/a*	300	64	364		(364)
Totals		***827***	***64***	***891***		***(730)***

Forest Resource Potential

	Sawdust	Chips & Bark	Total		VA only
Additional from For. Harv. Ops.	*n/a*	9,100	9,100		(2,150)
Totals		***9,100***	***9,100***		***(2,150)***

Dominion Energy is contemplating the development of a new power plant to be located in Southwest Virginia. As currently configured, this facility would be a circulating fluidized bed (CFB) boiler capable of co-firing coal and woody biomass fuel with an envisioned gross output of 550 MW. The design limitations of the CFB allow a maximum of approximately 10% of the fuel to be woody biomass (representing approximately 55 MW). Two locations have been proposed, one near Carbo (Russell County), and the other near Virginia City (Wise County), Virginia.

In an effort to determine the feasibility of co-firing with a woody feedstock, the Virginia Coalfield Economic Development Authority (VCEDA) has contracted with Virginia Tech to assess the current markets for wood and wood waste in the area. This assessment will encompass an evaluation of: the current market for wood waste within a 50 to 100 mile radius of the proposed energy facility, the potential future market for wood residues, the existing standing forest resource within the area, and possible regulatory or legislative limitations to using this resource.

Types of Woody Biomass

In the context of biomass combustion for this particular power plant, particle size is not a determinant factor of energy output so long as the feedstock is within the specifications of the CFB design. The CFB boiler is flexible enough in its design to accept a wide range of wood fuel up to 5cm in size, except stringy materials or wood flour (very fine wood residue). As a result, hog-fuel, chips (‘clean’ and ‘dirty’[1]), bark and sawdust can all be considered; however coarse residues such as log landing residue and sawmill slabs will need to be chipped before introduction to the boiler (see Figure 1 for residue types). The design of the proposed plant also has accounted for significant ash production which allows for inclusion of bark and ‘dirty’ chips. This stipulation opens up a variety of possible procurement sources.

The major concern for extracting energy from woody feedstocks is moisture content. Bone dry wood fuel will burn at around 8,600 BTU/lb, air-dry materials, with moisture content (MC) around 20%, will burn at around 6,000 BTU/lb, while green fuel, which can have MC around 50-60% will release around 2,000 BTU/lb (Figure 2). These values are averages based on lower heating values (a better estimate for real-world applications) and account for the energy released by the solid wood portion of the fuel. Because energy is measured here in terms of BTU per pound, the values are independent of density differences expected between varying species. While some pines have resins which might increase the energy output per pound, in the Southern Appalachians, the stocking of these trees is low enough to be considered insignificant for the purposes of this analysis.

[1] Note: ‘Clean’ chips are those produced primarily for the pulp and paper industry and have very low bark content, typically less than 1.5% achieved through removal of bark prior to chipping in addition to screening once chipped. ‘Dirty’ chips have a high bark content as a result of chipping whole trees, tree tops, and or slash.

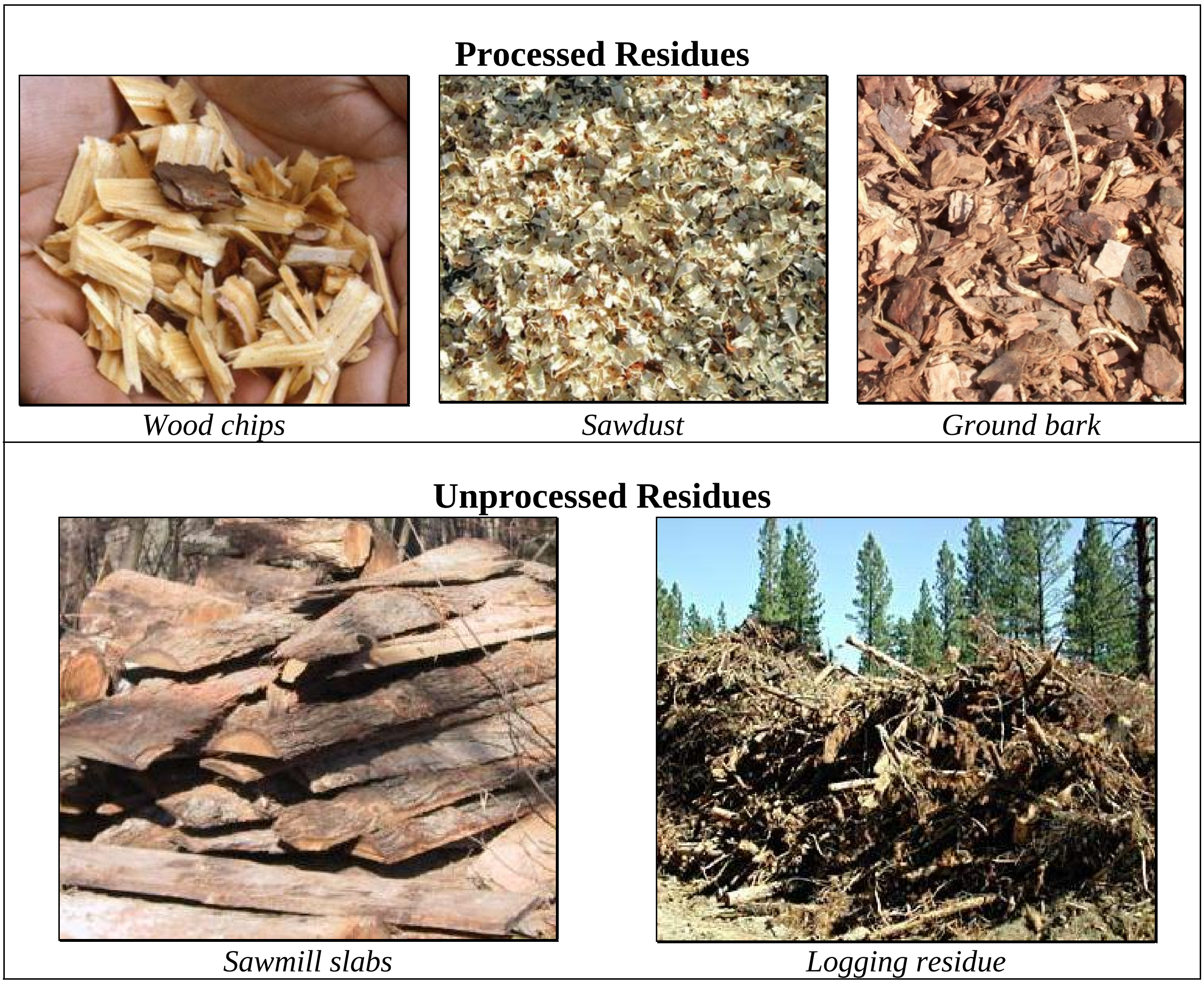


Figure 1: Common wood residue types

The expected moisture content of the material received at the mill power plant will have a great impact on the predicted amount of material needed to sustain the 55 MW contribution desired from woody biomass. As shown in Figure 2, as moisture content rises above 30%, the amounts needed to sustain the same energy output begin rising steeply. The amount of drying to which residues have been submitted will differ based on their source, whether directly from the woods (i.e. green trees), primary wood products manufacturers, or secondary manufacturers. Table 2 shows some sample residue types and the range of expected moisture contents from each.

Based on the assumption of 6,000 BTU/lb as provided in the scope of work for this project, this facility would require around 1,100 tons of feedstock per day, or approximately 400,000 tons per year. However, using the BTU/lb values from the literature, with the average MC of woody biomass delivered to the plant at 50%, 890,000 tons/year will be required.

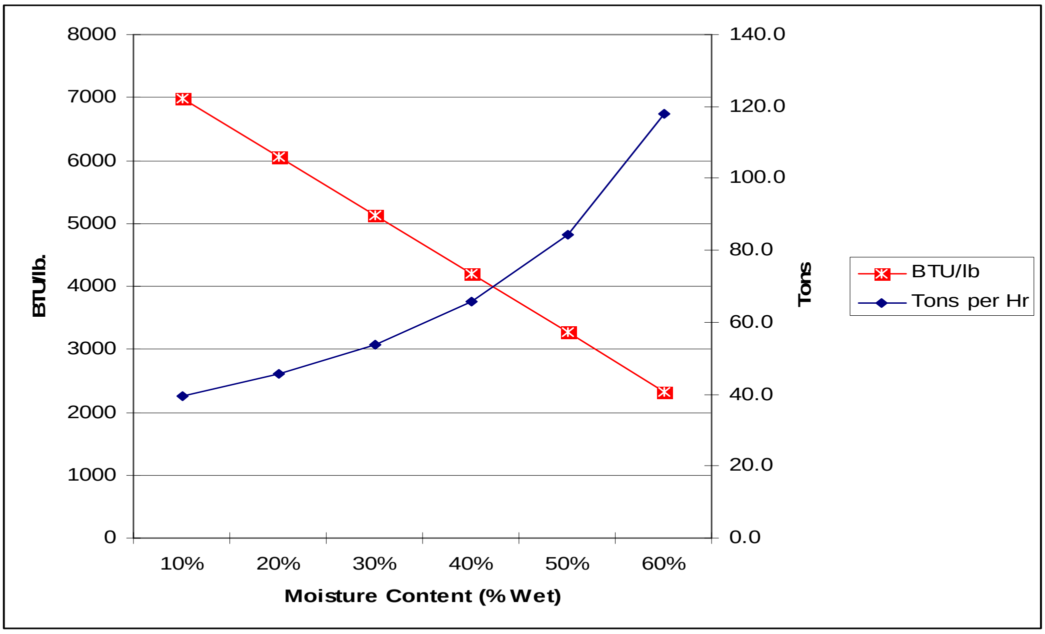


Figure 2: Effect of fuel moisture content (percent wet basis) on fuel energy content (BTU/lb) and tons per hour required to burn to maintain 55 MW output

Table 2: Moisture and energy contents for select residue types				
	Whole Tree Chips	**Coarse Residue Chips**	**Sawdust**	**Secondary Chips**
Moisture Content (%-wet)	**45-60**	**45-60**	**45-60**	**5-15**
Energy Content (BTU/lb)	**2500-3400**	**2500-3400**	**2500-3400**	**8000**
Source: Finnish Wood Fuel Characteristics from Forest Energy 2006[2]				

Geographic Area of Interest

The current procurement plan envisions consumption of a majority of wood residues from primary wood processing facilities and land clearing operations in the area. As such, transportation will be a critical factor in determining the availability of the resource. One of the major limiting factors in the Southern Appalachian region will be the fractious road network.

Due in large part to the rugged topography of the area, transportation times and road distances are much greater than might be expected for a straight line distance (Figure 3). Within a 50-mile radius around the power plant locations, the actual travel time is typically 90 minutes or more. The major corridors serving the power plant area are US Highways 23, 19, 460, and 58. These thoroughfares ease transportation within much of southwest

[2] www.woodenergy.ie/biomass_fuel/biomass2.asp

Virginia and into eastern Kentucky and northeastern Tennessee, and the likely feedstock sources will come from this zone.

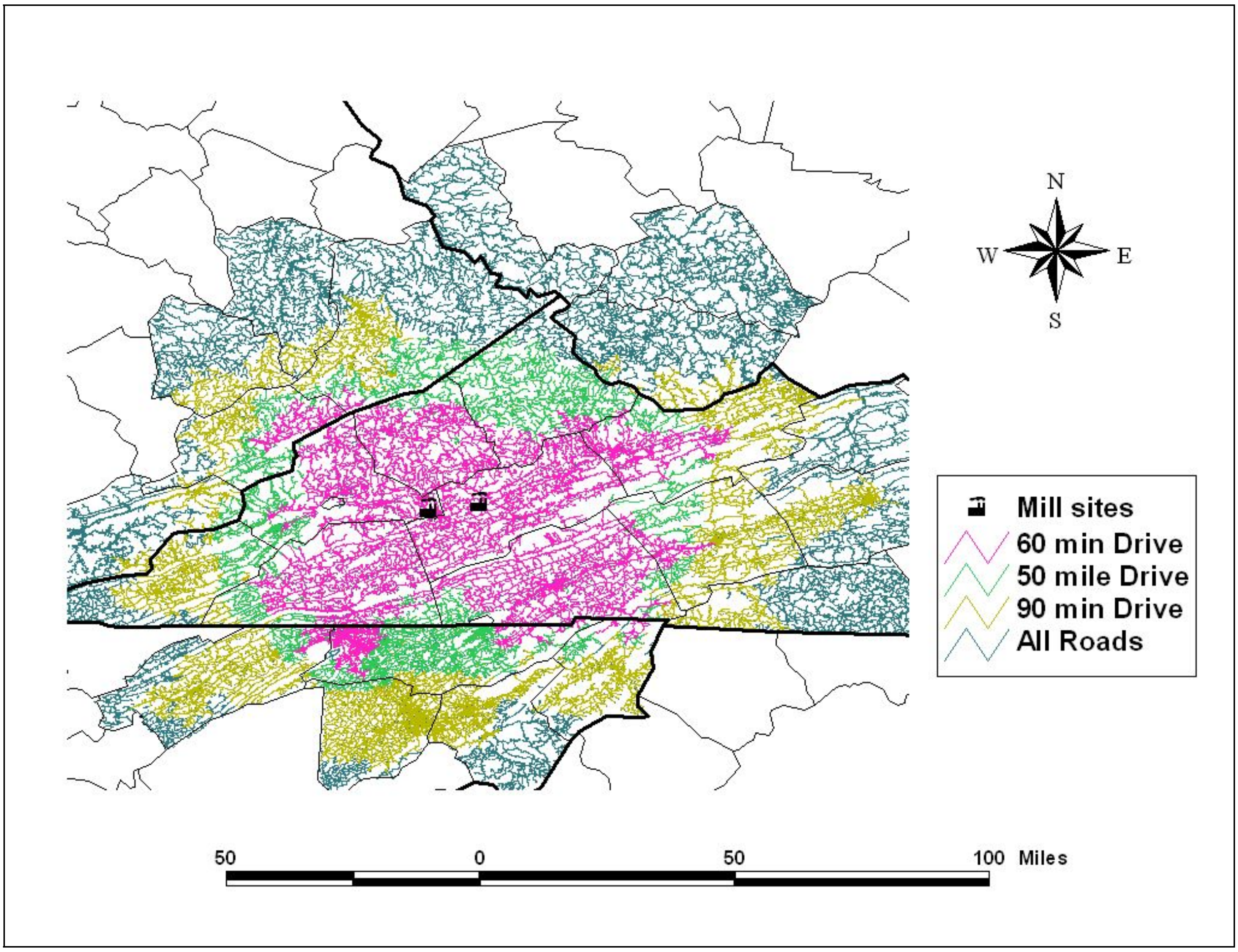


Figure 3: Drive times and distances from power plant locations

An analysis of the available resource must account for fully supplying the facility entirely from standing material in the area. While the plant will not be processing whole trees into chips onsite, this will ensure that introduction of the facility will not place an undue burden on the natural resources of the area. For purposes of standing resource inventory, a straight-line distance of 100 miles can be used, as the raw material may be harvested and delivered to processing facilities closer to the proposed power plant.

Evaluation of Existing Woody Biomass Residues

The principle supply facility in this region is the chipmill operated by Mountain Forest Products, located in Clintwood, VA. This facility currently produces approximately 250,000 tons of chips per year, all of which are sold to pulp and paper facilities, with Weyerhaeuser in Kingsport, TN purchasing the majority. This level of production also generates 800-900 tons of bark and around 300-400 tons of sawdust per week (42,500 and 17,500 tons per year respectively). Under the current production agreement, Weyerhaeuser agrees to purchase the bark; however, it appears that this material is essentially available and is purchased by Weyerhaeuser purely as a concession to Mountain Forest Products.

Additionally, the chipping facility is not operating at full capacity. If sufficient purchase guarantees are in place, they are capable of producing an additional 50,000 tons of chips per year with their current setup, and are able to add a second shift that would generate another 250,000 tons of additional chips, with the associated residues as well. As the only sizable chipping facility within a reasonable haul distance from the proposed locations, they will be a critical source of raw material. One important note regarding the chips produced in Clintwood, because they are primarily designed for production of paper chips, the output is uniform in size and extremely clean (less than 1.5% bark) and may, therefore, have a higher cost than residues from manufacturing facilities.

There are a number of other large residue producers in the area. Large-scale sawmills and hardwood flooring and furniture facilities offer tremendous opportunities for biomass; however, most have agreements in place to sell most or all of the wood residues produced by their manufacturing processes. Based on individual interviews with processing facilities in the area, and utilizing previous research methodologies to extrapolate data over the entire procurement area, it is estimated that 2,800 tons of woody residue and chips are produced from these facilities per calendar day, which equates to around 950,000 tons per year, with approximately 650,000 tons per year being generated in Virginia alone. While much of this material is already marketed to other facilities, the location of the proposed power plant sites places it in a strategic location to take advantage of a number of these sources (Figure 4).

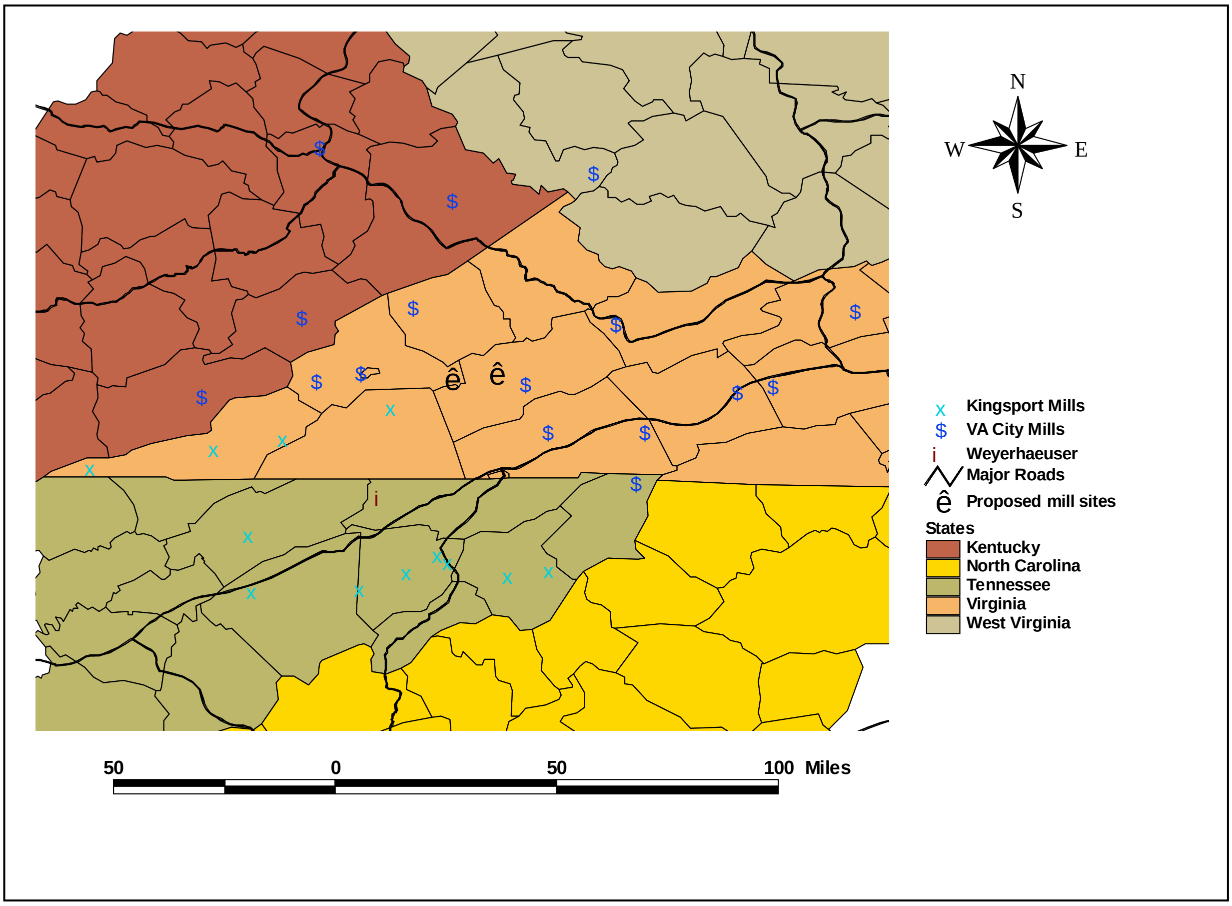


Figure 4: Wood facilities producing residues and their relative proximity to Virginia City, VA or Kingsport, TN

The majority of the residues produced from these areas is green (50-60% moisture content), however, there are secondary manufacturers in the area which produce dry residues, most notably the BA Mullican Flooring plant in Norton, VA, three secondary manufacturers in Smyth County, VA and a number of furniture manufacturers in Washington County, TN. While the facilities in Tennessee are positioned closer to their current residue market than to the Russell County locations, the Virginia manufacturers are slightly closer to the proposed cogeneration sites.

Evaluation of Potential for Chips Direct from Forest

Of the 70-county region surrounding the proposed power plant locations, 83% of the area is covered by forests; however, 13% of the area is deemed inaccessible or too poorly stocked to qualify as merchantable[3]. There are approximately 11 million acres of accessible forestland, representing 70% of the total land area. Currently growing on these forestlands are 18 billion cubic feet of timber (approximately 411 million tons), of which approximately 90% is hardwood species (Figure 5). The current timber harvest level within this region, from private property only, is 210 million cubic feet (4.7 million tons). Even with harvests at this rate, the area still has a net growth of 419 million cubic feet (9.4 million tons) per year. The counties in Virginia account for 3 million acres of accessible forestland and approximately 96 million tons of timber currently growing on private timberlands. The net growth on the Virginia timberlands is 2.1 million tons per year.

The species breakdown within this area is shown in Figure 5. The majority of the forestland is composed of hardwoods. The softwoods are mostly white pine (*Pinus strobus*) and eastern hemlock (*Tsuga canadensis*). Much of the hemlock is dying or standing dead due to an insect infestation in the US which has ravaged eastern hemlock nationwide.

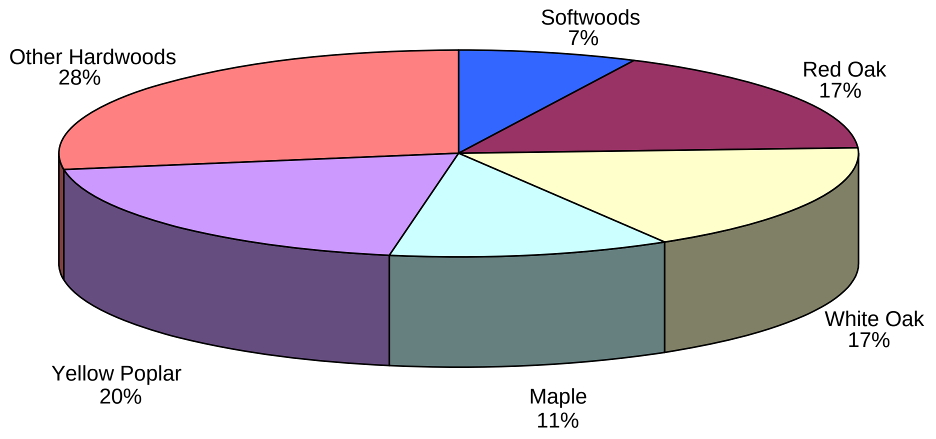


Figure 5: Species breakdown within procurement zone

[3] Note: data from the US Forest Service FIA database: http://ncrs2.fs.fed.us/4801/fiadb/

Material Costs

The principle concern with procuring the required volumes of woody feedstock will be ascertaining the appropriate equilibrium price. Very little information is available regarding the current prices being paid for comparable woody residues; however, based on what information can be gleaned, estimates of varying price levels can be made. In 1994, a study was conducted by the Virginia Department of Forestry regarding wood waste usage for energy production which listed the average price paid for sawdust at that time as $9 per ton, with a range from $5-$15 per ton. A 2002 study conducted by the Virginia Tech Department of Wood Science and Forest Products investigating wood residue markets within Virginia found the average price received by hardwood sawmills for chips was $22 per ton, for sawdust $10 per ton and for bark $14 per ton. Using these prices as a guideline, it can be inferred that at the low end, a delivered price of around $12 - $15 would provide a market for some sawmill residues and freely available material being processed by a grinder (i.e. hog fuel) and hauled locally. At prices approaching $20 - $25, competition can be made for “clean” chips currently being sent to pulp and paper mills. Delivered prices of $30 - $35 would likely provide sufficient additional incentive for currently operating logging contractors to make modifications to their operations in order to supply chips directly to the power facility (without requiring delivery first to a chipping facility). Obviously, as the price increases, residues also can be hauled economically from more distant wood processing facilities (Figure 6).

From the supply side, four components comprise the basic cost of delivered chips (depending on their source): cost of raw material, harvesting/logging, chipping/grinding, and hauling. That is:

Delivered Cost = Raw material cots + Harvesting costs + Chipping costs + Transportation costs

Regardless of the source of the feedstock, all suppliers will incur at least hauling costs associated with transporting the processed biomass to the power plant location. Current estimations of trucking costs are approximately $0.15 per ton per mile. Using this guideline the impact of distance traveled on the break-even costs of delivering material to the facility can be shown (Figure 6). For example, if the delivered price for chips is set at $25 and a mill 50 miles away sends a tractor trailer load (assumes 25 tons), they will have around $17 to cover their raw material and processing costs. Assuming chipping requires an additional $4 to $4.50 per ton, they are left with $13, to cover the cost of the raw material itself as well as any harvesting costs, if they have been incurred. For raw material costs, stumpage prices on pulp wood currently range from $3-$6 per ton. As fuel prices continue to rise, these figures will inflate as well.

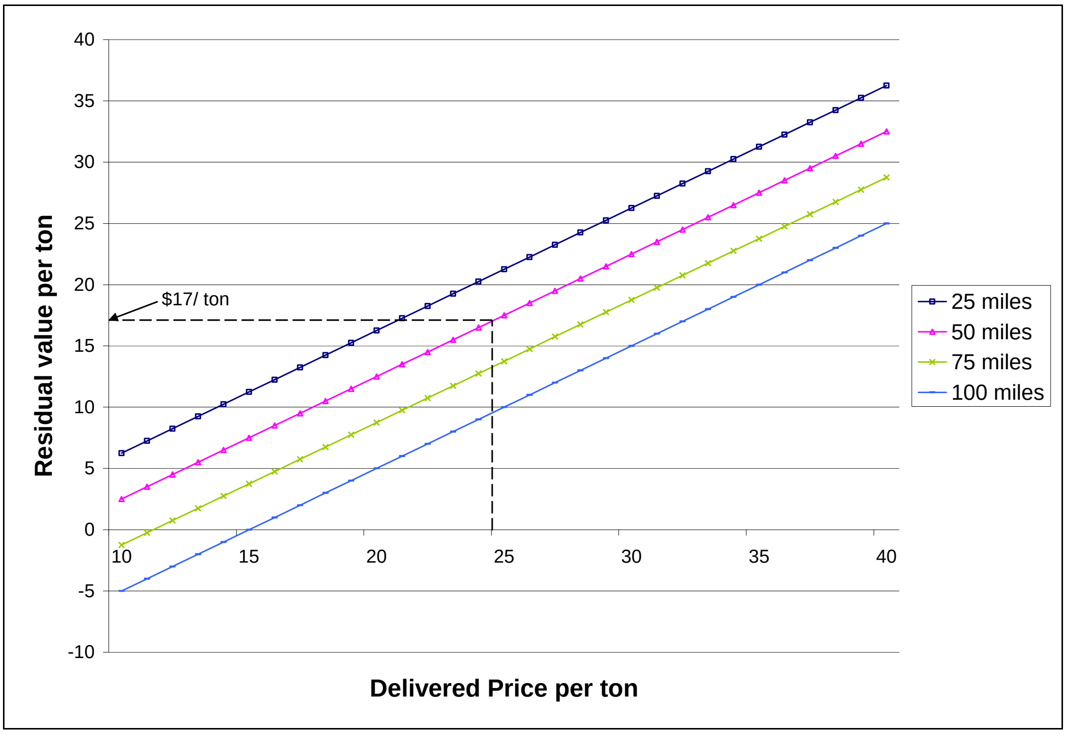


Figure 6: Impact of delivered price and haul distance on hauling costs of biomass

Possible roadblocks to biomass procurement

From existing processing facilities

The major facility competing for existing woody residues in this region is the Kingsport, Tennessee Weyerhaeuser paper plant, which utilizes bark and sawdust to fuel its boilers and chips as its raw material. Most of the chip residues produced in the region are sent here, and for large-scale producers, bark and sawdust may be sent here as well when transportation costs allow. Blue Ridge Wood Products in Bluefield, VA purchases some sawdust to fuel its boilers. Also, some residues in the area are sent to the Trigen Biopower plant in Eden, NC. Bark is occasionally marketed close to smaller mill facilities for use at the local level.

From forest operations

At present, there exist few markets for low-grade small diameter wood across the majority of the procurement radius. A pulp mill operated by Weyerhaeuser is located approximately 40 miles south of the proposed Moss #3 site. North of Russell County, VA, however, there are no markets for pulpwood-sized material. The introduction of a wood-consuming boiler in this area would allow for the utilization of raw material which currently has no market. A closer examination of the area shows that the major agricultural and urban areas are immediately south and east of the proposed locations, while to the north are extensive areas of forestland (Figure 7). Much of this area is relatively undeveloped due to the rugged terrain of the region, but harvesting systems are present which can deal with these difficulties. Examining the US Forest Service Forest Inventory and Analysis timber harvest statistics in the area surrounding the proposed power plant locations shows that despite the abundant forest resource, 17% of the counties harvest no pulpwood and an additional 42% harvest less than 100,000 cubic feet. For comparison, 89% of these counties harvest more than 1,000,000 cubic feet of sawtimber-sized material and the remainder harvest over 200,000 cubic feet.

Forest management in Southwest Virginia faces numerous obstacles including operational difficulties due to steep terrain, historical poor management practices, and lack of markets for low-grade materials. One of the most unfortunate manifestations of these difficulties has been a continuing trend towards "high-grading" in many areas. High-grading refers to removing larger high-value trees while leaving poor-quality and smaller trees. The result is that these low quality trees are left to regenerate the site, producing more poor-quality trees. Without a market for low-quality material, there is no incentive to stop this trend. A facility able to accept chips from low-grade material offers the opportunity to provide an incentive to reduce high-grading in favor of stand improvement harvests, wherein low-quality material can be removed and the higher-quality trees can be left to grow with reduced competition.

Current forest removal levels in Virginia are lower than the rate of forest growth, meaning that there is an annual increase in the amount of wood in the state's forests every year. The major source of reduction of forests is conversion to other uses, mainly industrial or residential. Within the procurement radius of the proposed power plant sites, there was a net growth of 419 million cubic feet on private timberlands. This figure does not include the growth from government lands or land without a suitable number of trees to be considered economically merchantable. This represents an annual surplus of 9.4 million tons of wood (2.1 million tons in Virginia) that could be removed from private forestlands without reducing the total growing stock of forests within 100 miles of the power plant locations. Thus, even if the facility were to procure its supply entirely from standing timber, the maximum annual consumption of the facility would only represent 4% of the current annual net growth in the area, and the forests would continue to add over 400 million cubic feet of volume each year. Shrinking the area in question to the 50 miles immediately around the sites shows a surplus of 130 million cubic feet or 2.9 million tons per year. Thus, if the power plant were to operate at full capacity using just standing timber from the 50 miles immediately surrounding it, the volume of standing wood in this area would still increase by over 110 million cubic feet each year.

This does not necessarily mean an increase in timber harvesting. At present, the US Forest Service reports annually on residual wood materials left after harvesting operations[4]. Within a 50-mile radius of the power plant locations, 20 million cubic feet of logging residues were generated in 2002 alone. Not all of this material would be available for bioenergy, however, if 50% could be recovered, it would represent a supply of 225,000 tons/yr (assumes 45 pounds per cubic foot).

Legislative implications

At present there are very few existing ordinances which might impact the supply-side of the proposed power facility. Most sawmills are required to operate within the limitations of environmental quality standards, and the only potential impacts from the Dominion facility would occur if supplying sawmills began to hold significantly greater volumes of wood waste on their current woodyard. For smaller sawmills which are not currently

[4] Data located at: http://ncrs2.fs.fed.us/4801/fiadb/rpa_tpo/wc_rpa_tpo.ASP

storing wood waste for subsequent sale, initiating a waste pile might subject them to further regulation as well.

From a forest operations perspective, the only harvesting restrictions in place in southwest Virginia is within the city of Bluefield, which limits harvesting above a certain elevation. The potential impact of this regulation is insignificant. Interstate commerce of wood products should not pose a problem unless outbreaks of forest disease or pests occur, in which case it is not uncommon for effected species to be quarantined within the effected state/area in order to limit spread.

Potential Alternative Supply Opportunities

In addition to the existing resources listed above, there are opportunities for alternative supply methodologies which are not currently in place in the Southern Appalachian region. The most attractive of these opportunities is placing a chipper in the woods with harvesting contractors. This eliminates the need to transport material from the woods to a chip mill and then to the power facility. The two most feasible configurations are to either utilize a large-scale in-woods chipping crew, dedicated entirely to cutting and chipping small material, or to initiate a small crew outfitted with a chipper which travels between logging operations as material becomes available. With the second configuration, the expense of a full logging crew is replaced by a crew that simply works for loggers on a contract basis to chip excess material that would otherwise be left in the woods. In each scenario, chips generated in the woods would be blown directly into chip trucks and driven to the mill (Figure 8).

Figure 8: In-woods chipping of logging residues

Utilizing a chipper that travels between logging jobs would introduce the opportunity of using logging residues for energy. In counties within a reasonable distance of the power plant facility, this represents around 500,000 tons of residue, though certainly all of this material neither can nor should be harvested. Capturing ten to twenty percent of this unused residue, though, would represent a significant input to the facility.

Conclusion

Approximately 504,000 tons of residues (235,000 in Virginia) and 527,000 tons of wood chips (366,000 in Virginia) are generated per year from the woody biomass sources within the procurement area for the proposed power plant locations (Table 1). Almost all of this material is currently marketed; however, opportunities exist to contract 300,000 to 350,000 tons of chips and residues with Mountain Forest Products. In addition, approximately half of the wood processors in the area which currently sell their residues in Tennessee are closer to the proposed locations. Theoretically, if the prices offered for the material are comparable, the transportation cost savings should encourage sale of these residues to the power plant. If the market is favorable, processing of logging residues could open a third source of woody feedstock. These three sources should prove more than sufficient to fuel 55 MW of power generation.